ARI Research Note 88-39

FIRST YEAR HUMAN PERFORMANCE RESEARCH ACTIVITY

Vreuls Research Corporation

for

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This research note describes the first year of work performed by Vreuls Research Corporation while under contract to the Army Research Institute's Fort Leavenworth Field Unit, supporting the Field Unit's effort in assisting the Combined Arms Center (CAC) to improve command and control (C^2) systems.

The focus of the research is to improve command and control systems through enhancing human performance on information processing and decision-making tasks. Three research projects are being conducted under the program: Improved Methods for Command Group Training, Advanced Technology for Command Staff Operations, and Evaluating Command Post Performance.

Other reports detailing the research and findings, designed and conducted experiments, and necessary literature reviews to support the various tasks accomplished have also been published.

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Computer Mediated Communication
Natural Language Processing
Artificial Intelligence
Dialogue Guidelines

FIRST YEAR HUMAN PERFORMANCE RESEARCH ACTIVITY
Contract MDA 903-86-C-0210

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First Year Human Performance Research Activity

For the period 11 June 1986 to 10 June 1987

INTRODUCTION

This annual report describes the first year of work under a contract by the Vreuls Research Corporation (VRC) for the Army Research Institute, Fort Leavenworth Field Unit. The Fort Leavenworth Field Unit of the Army Research Institute (ARI) conducts a program of research in support of the Combined Arms Center at Fort Leavenworth. The primary goal of its research is to improve the effectiveness of command and control (C2) systems through the enhancement of human performance on information-processing and decision-making tasks. The program encompasses three research projects: Improved Methods for Command Group Training, Advanced Technology for Command and Staff Operations, and Evaluating Command Post Performance.

The purpose of the VRC contract effort is to conduct reviews, analyses, and experiments on human performance in parallel with, and in support of, the Fort Leavenworth Field Unit's larger-scale research with complex command post simulations. The research in this program is to be conducted on a general subject population where possible, in small scale research facilities, and in a manner which is as independent of the larger-scale research as possible On the other hand, the individual tasks in this program should be part of an efficient coherent approach and be selected to anticipate, respond to, or complement the Field Unit's larger program.

The tasks specified in the Statement of Work (SOW) for this program are as follows:

1. Recommend alternative I/O devices and procedures for evaluation.
2. Conduct I/O device evaluation research.
3. Recommend alternative graphic communication devices for evaluation.
4. Conduct graphic evaluation research.
5. Recommend alternative presentation techniques for evaluation.
6. Conduct data presentation techniques research.

The details of these SOW tasks were to be determined through a process of research planning and Contracting Officer's Representative (COR) direction during progress review meetings and informal communications.

The remainder of this annual report describes the directions taken in the first year of work and the progress which has been achieved. Work has been accomplished on all of the above tasks to varying degrees. The effort has ranged from completed and published reports to design of experiments and the necessary literature reviews to support the task accomplishment. The appendices present executive summaries for the technical reports produced in the first year.

KICKOFF MEETING

A kickoff meeting was held at Fort Leavenworth shortly after the initiation of the contract. The proposed work was reviewed in the context of planned Field Unit technical activities. In particular, it was pointed out that this contract was expected to provide information as needed by a larger-scale research simulation support activity, the Experimental Design, Development and Integration Center (EDDIC). The current contract would have to anticipate some of these information needs since the larger contract would not be initiated for some time.

The following tasks were discussed at this meeting:

- Role-players/controllers in training simulation. The fidelity of role-player/controller tasks in training was an issue requiring investigation to establish a basis for further research and development. The communications created by the role-players/controllers may differ from actual field communications, which might affect the value of training.

- Computer-mediated distributed command groups. Command groups may be distributed for survivability, and may be provided with increasing amounts of computer support. The effects of computer support and geographic separation on groups has not been extensively investigated, especially in the context of Army command tasks.

- Artificial intelligence (AI) interface issues. A number of AI issues required review and analysis. An item of immediate interest was the specific use of AI techniques for command and control applications.

- Natural language interface. The concept of an adaptable user interface is involved in other ARI Field Unit research, and an analysis of natural language interface issues was desirable in this context.

- Guidelines for dialogue specification. There was a need for the development of guidelines for person-computer dialogue for use in Army command applications. A literature review was needed to lead to the development of a suitable guidelines document as well to a document which identifies needed research.

It was agreed that each of theses areas would be investigated with regard to desirable methods of attack, feasibility and payoff. This list, in fact, became the basic structure for the first year of work, and each of these areas are addressed in the following sections.

ROLE PLAYER/CONTROLLER MESSAGES

In Command Post Exercises (CPX) for the training of Battalion Staffs, a number of people serve the functions of relaying information from a computer simulation of the battle to the staff in training, and from the staff to the computer simulation. These people play a role in the sense that they try to behave in a manner comparable to Field Training Exercises (FTX) but with a computer interface instead of a real-world interface. While these role-players may derive some training benefit from the CPX, the training of the Battalion staff is the primary objective. If, however, the role-players behave in the CPX environment in a manner different from the FTX environment, there is the possibility that staff training may be adversely affected.

To explore this potential problem area, a strategy was developed to (1) obtain samples of messages from the FTX environment, (2) obtain samples of messages from the CPX environment and then (3) compare the two samples to identify important differences.

FTX Data Collection

Through the efforts of the COR, arrangements were made with the ARI Presidio of Monterey Field Unit to copy audio tapes collected during National Training Center, Fort Irwin, field exercises. A meeting was held at the Presidio of Monterey Field Unit on 27 August 1986 with Maj. Williams and Dr. Atwood; it concluded with obtaining access to data for a rotation which was on hand and had been catalogued. Subsequent trips were made to record samples of communications to audio cassette tape and to transcribe these for analysis.

Careful sampling and analysis was required prior to final data collection because (1) the amount of recording is quite large, for example, it would take 10 person years of labor just to play back all channels, (2) much of the recordings were of very poor quality and sufficient good quality communications had to be mapped out, and (3) it was not certain whether communications could be obtained for all types of role players. Consequently, the initial data collection was based on a channel-hopping scheme to collect samples for preliminary analysis.

The preliminary analyses were primarily directed toward establishing communication quality and identifying the presence of specific role-players; these analyses were based on manual rating of quality and files of call-signs. Some role-player types were not abundantly represented and no 4.2 Mortar message traffic was found (although tapes from both mountain top receiving sites were sampled); as a consequence, the subsequent data collection concentrated on task force command and conduct of fire role players. A final trip was made for continuous recording of the specific channels for these role players. These channels were then played back at least twice: once for initial transcription, and again for verification and addition of analyst codes.

CPX Data Collection

Through the efforts of ARI Fort Leavenworth Field Unit personnel arrangements were made for the collection of data at the ARTBASS Center, Fort Hood, during the period 7-11 December 1986. After an initial day of setup and checkout, data were collected for three days: a deliberate attack, a deliberate attack preceded by a distinct reconnaissance phase, and a night sector defense. Audio recordings were collected from four communication networks, however, the quality was only sufficient for the Battalion Command and FIST/FSO nets. Additionally, other data collected included the OPORDs, overlays, and computer post-processing listings.

Additional Data Collection

Note that the Battalion staff and role players were not the same at CPX and FTX. However, the staff at the CPX has now performed a rotation of training at NTC, Fort Irwin, and comparable FTX data can be obtained. Arrangements have been made to acquire the additional data, and the decision has been made with the COR that the data will be copied for possible follow-on analyses.

Technical Report

This task culminated in a published report, entitled, "Pilot Comparisons of Communications for a Field Training Exercise (FTX) and a Command Post Exercise (CPX)", on pilot research into the differences in radio message traffic between a Command Post Exercise (CPX) environment and a Field Training Exercise (FTX) environment. Comparing existing, recorded radio transmissions from the National Training Center's opposed force FTX to recorded transmissions from an ARTBASS CPX yielded a report on apparent differences in the two environments. Statistically, trends of difference were noted, but statistically significant differences were not apparent in the sample. Subjectively, a difference was noted by examining key words and word sets that were unique to the particular environment. (See Appendix A.)

Follow-on Research

Follow-on research into this environment is planned. The first project will ask an expert (experienced army officers) to rate messages from both environments using bi-polar adjective sets. The experts also will be asked to attempt to differentiate between CPX and FTX messages. In a post-survey questionnaire they will be asked about the relevance of the experiment or survey, asked to comment on the method of rating, and asked to address the training differences in the two environments, based on their previous experience.

Results of the above described task will lead to other follow-on tasks that will address possible creation of messages by experts from a modified ARTBASS alert, development of a rule based model that will modify the present ARTBASS alert, and possibly, examination of a model that will replace the role-player/controller for ARTBASS.

The relevance of this project is dependent upon a perceived difference in training in the CPX and FTX environments. The goal of the project is to affect training in the CPX to allow better performance and training in the FTX.

The approach taken for this task was to perform a comprehensive review of the literature, and then to formulate a research plan based on the issues which were identified. A literature review has been conducted; it included small-group, communication, military command and control, and graphic display literature. A preliminary review and research plan, entitled, "Research Plan for Computer Mediation of Distributed Command Staff Functions", was developed for discussion with the COR. Based on these discussions, additional analyses and candidate research strategies are being developed at this time.

This study addresses issues that arise from the performance of standard command and staff functions when the work must be performed by individuals who are geographically separated. It is assumed that the individual's work will be performed through interaction with other members of the staff and that cooperation and/or coordination will be required. It is further assumed that the individual's work and necessary interaction will be performed through interaction with a computer. As with most staff actions, a supervisor will be available for problem resolution, coordination and for approval of the final product.

Consequently, the basic paradigm to be treated in the proposed research is that of two individuals, and a common supervisor, who each work with a computer as well as with each other, as shown in Figure 1. Additionally, each staff member will perform other work of varying priority.

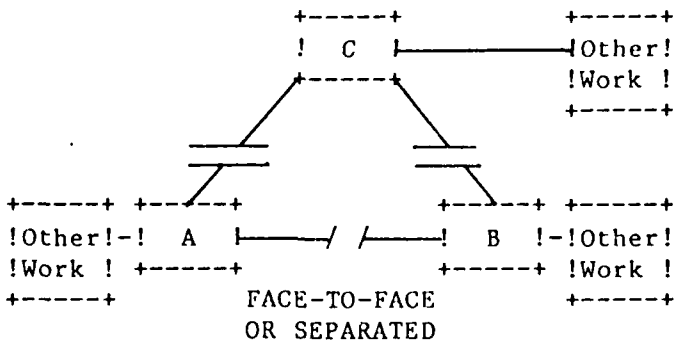

Figure 1. Basic experimental paradigm.

The fundamental research issue is the difference in group performance when the staff members work face to face in the same location as compared to working from geographically separated locations. A goal is to explore the impact of such remote operations on C2 operations when the tasks are computerized and to gather information which may reflect on the design of such systems. Once the tasks are computerized, for example, the operators may have the ability to share textual information, data bases, graphic displays, and the ability to point to display items, or highlight certain pieces of information. Such features may augment team processes to the extent that better performance is realized from separate locations than is now possible with face-to-face manual operations.

It currently is proposed that an initial study be based on Figure 1, which is a minimal group size and would use readily available point-to-point communications; however, parallel development effort would be conducted to rapidly introduce multi-person communication networks based on Ethernet hardware.

The relevance of this project is keyed to the fact that command and control nodes will have to operate from locations that may be remote from staff counter-parts. Tasks, both collaborative and coordinative, must still be accomplished; graphic communication and individual and group computer aiding may assist in task accomplishment in a timely and accurate manner.

This work is currently in progress, and an approved research analysis and experimental plan will be ready early in the second year of work.

SURVEY OF ARTIFICIAL INTELLIGENCE TOOLS

System developers for command, control, communications and intelligence (C3I) have a need for a survey of the types of tools which exist to aid in the development of expert systems. This is especially true for first-time expert system developers. In response to requirements of CACDA, the COR defined a task under this contract to satisfy the need. As a consequence, a survey of 93 current expert system development tools was completed. The results of this analysis were documented and published as a survey that included a brief description of tool features (e.g., knowledge representation and inference method) and a checklist of the 93 tools. The checklist noted features of each tool. (See Appendix B)

NATURAL LANGUAGE PROCESSING IN THE ADAPTABLE USER INTERFACE

Use of natural language in adaptable user interfaces was examined in some detail to determine if currently available methods in the domain of natural language processing can be mapped onto the concept of an adaptable user interface (AUI). Three major elements of the AUI framework (command interpretation, output selection and interface control) were discussed in terms of current natural language systems and a correspondence between natural language and AUI is proposed. A draft paper was developed and submitted. (See Appendix C)

DIALOGUE GUIDELINES DEVELOPMENT AND RESEARCH PLAN

This task has the dual purposes of producing (1) a design guide for use by military personnel engaged in the design of user aids, and (2) a research analysis which will identify deficiencies in current knowledge and then recommend needed research.

This task will address the design of person-computer dialogues for all forms of C2I user interfaces, with examples to be based on selected primary applications. The dialogue types will minimally include: (1) question and answer, (2) form filling, (3) menu selection, (4) function keys with command language, (5) user-initiated command language, (6) query language, (7) natural language, and (8) interactive graphics. Dialogue design principles and specification methods will be emphasized; input/output devices, screen design and evaluation methods will be addressed but not emphasized. As an adjunct, a disk may be developed which will allow the user to gain hands-on experience with alternative dialogue types.

During the literature review and development of the design guide, critical missing data and unsupported guidelines will be noted. Based on these observations and an assessment of the need, a technical report will be developed which discusses these deficiencies and identifies needed research.

The preliminary literature review has been completed at the close of the first year of work. Both a top-down and a bottom-up analysis are currently proposed: More than a dozen excellent books are available for use in the initial top-down development of the design and specification guidelines; however, there will be a need to identify the supporting empirical research literature in key areas for the bottom-up definition of needed research.

WORKSHOP PARTICIPATION

During the course of the first year, two workshops were held at Fort Leavenworth as part of the contract supporting the development and operation of the EDDIC Facility. The first of these related to EDDIC human performance research and decision aiding (24-25 March 1987), while the second related to development of training modules for EDDIC (20-21 May 1987).

Informal presentations were made at both of these meetings. The computer-mediated distributed command group experiments were discussed at the first meeting; these experiments demonstrate a possible division of activities between the larger EDDIC activity and smaller laboratory efforts. An informal paper also was prepared for the second workshop; it identified some previous work and issues related to development of knowledge-based models for team member substitution.

A major benefit derived from attendance at these workshops was to gain context knowledge of the EDDIC effort. This knowledge will be useful when additional laboratory-level experimentation and analysis requirements are identified.

SUMMARY

At the end of the first year of work, three parallel paths of work have been established: (1) investigation of role-players/controllers in training simulation, (2) investigation of computer-mediated command groups, and (3) development of dialogue guidelines and related research. These investigations will be carried into the second year of work, developing into mutually enhancing paths of analytical and empirical studies.

APPENDIX A

Linville, J. M., Obermayer, R. W., Liebhaber, M. J., and Solick, R. E. (June 1987). Pilot comparisons of communications for a Field Training Exercise (FTX) and a Command Post Exercise (CPX)

EXECUTIVE SUMMARY

REQUIREMENT

This study compares messages created in a command post (CPX) environment to those of a field training exercise (FTX) to examine the realism of the CPX. The FTX environment is a highly-realistic field exercise conducted against aggressor forces and is used as a baseline for comparison. In the CPX, a computer model generates information necessary for battlefield reports, and messages are developed from the computer output by personnel who play the roles of higher and lower headquarters personnel. The training in CPXs must transfer to an FTX, and further, transfer to an actual battlefield. This study examines the message traffic from both FTX and CPX to determine if there is a difference, because then it would be conceivable that the actions and reactions of the commander and staff would also be different.

This report presents the preliminary investigation in a communication research program. It is an initial and exploratory step to collect a message data base and provide information upon which follow-on research can be based.

PROCEDURES

Audio communication tapes from an FTX were collected for a mechanized force in a defend-from-battle-position exercise. Similar audio communication recordings were collected from a mechanized infantry battalion undergoing a CPX. The communications were transcribed for (1) FTX Task Force Command Net, (2) FTX Conduct of Fire Net, (3) CPX Battalion Command Net, and (4) CPX Fire Support Team Net. Each transmission was identified and coded to indicate the type of information it conveyed. The analysis consisted of (1) an overall summary of the transcripts by information category, (2) linguistic analyses of message complexity, and (2) some preliminary statistical comparisons between FTX and CPX.

FINDINGS

The data presented in this report are limited to one CPX and one FTX battle. While there is a possibility that some of the conclusions based on these data may not be supported by a study with a broader scope, it appears to these authors that the computer-simulated CPX environment is characterized by greater quantities of seemingly more accurate and timely information that is qualitatively different from that of the FTX environment. An examination of unique words yielded recognizable differences between the two types of exercises.

UTILIZATION OF FINDINGS

A follow-on study should be performed which expands on the subjective analyses in this study by presenting samples of message traffic to expert judges and by using improved discrimination methods. If possible, the message traffic data base should be augmented with message traffic from additional battles.

APPENDIX B

Liebhaber, M. J. and Reidel, S. (March 1987). A survey of expert system development tools.

EXECUTIVE SUMMARY

REQUIREMENT

A need exists, especially for first-time system developers, to learn the types of tools which exist to aid the development of expert systems. Knowledge of these tools provides the option to acquire an existing tool which best meets the need or to build a tool. If already developed software can be used, it is usually more cost-effective to buy rather than to create such software from scratch.

PROCEDURE

Existing Expert System Development (ESD) tools were surveyed. Included in this survey were product announcements, reviews of existing tools, reports of tool use in research and applied settings, information obtained from a workshop on ESD tools, and discussions with tool users. A list of important ESD tool features was developed from the literature on expert systems. It included the following general features: Knowledge Representation, Control and Inference, Certainty Management, Hypothesis Handling, Knowledge Acquisition, User Interface, and External Access. Within these general features, sub-features were also listed and defined. Additional information was given, if it was known, regarding availability, cost, vendor support and address, system requirements, and typical applications.

FINDINGS

Ninety three (93) existing ESD tools were described in terms of their features, which are defined in the main body of the report. The tools are listed in Appendix A and a full description of the features of each tool is contained in Appendix B.

UTILIZATION OF FINDINGS

This report can serve as a reference to expert system developers or managers who need to learn what ESD aids are available and their general features, constraints, and costs. An in-depth analysis of these tools for any given type of application was not performed because such an analysis would depend upon the particular application.

It was noted that ESD tools are being developed constantly, thus this report captures only those tools which could be found readily at the time of the study.

APPENDIX C

Liebhaber, M. J. (March 1987). The use of natural language in an adaptable user interface

ABSTRACT

This paper presents an overview of some existing research in Natural Language (NL) processing and how that research relates to the concept of an Adaptable User Interface (AUI). Its goal is to show how certain aspects of NL can be incorporated into an AUI framework. An AUI is an intelligent interface between a human and a computer that is capable of adapting itself to individual user's goals, needs, and abilities. The intelligence of an AUI is contained in its models of users and tasks (applications the computer can perform). These individualized models are used to facilitate the human-computer interaction. The main feature of most NL processors is that they model their communicative environment. That is, they keep track of the context of the discourse. Unfortunately, most systems present a consistent interface to the user. However, NL research has also generated useful metaphors and techniques that can be applied to AUIs. Three major elements within the AUI framework; Command Interpretation, Output Selection, and Interface Control; are discussed in terms of current NL systems. Finally, a set for correspondences between NL and AUI concepts is proposed.